

PROCEEDINGS
OF
THE ROYAL SOCIETY.

January 11, 1866.

Lieutenant-General SABINE, President, in the Chair.

The following communication was read:—

“On the Colouring and Extractive Matters of Urine.—Part I.”

By EDWARD SCHUNCK, F.R.S. Received June 29, 1865.

(Abstract.)

Notwithstanding the labour bestowed by many eminent men on the chemistry of urine during the last sixty years, there are portions of the subject of which we have but a very imperfect knowledge. Of all the properties of urine, none is more obvious, even to the ordinary observer, than its colour; and yet very little is known concerning the chemical nature of the substances to which its colour is due. Our ignorance in this respect may be ascribed to various causes, among which may be mentioned the extremely minute quantities of these substances occurring in the secretion, the facility with which some of them are decomposed, their chemical and physical properties (which present to our notice very little that is characteristic), and, lastly, the little interest which they possess for the chemist, notwithstanding their importance from a physiological and pathological point of view. According to the author, the colouring-matters peculiar to urine may be divided into three classes, viz.—

1st. Those which are only found occasionally in it, in consequence either of disease or of some abnormal state of the system.

2ndly. Those which are produced by spontaneous decomposition, or by the action of reagents on substances, either coloured or colourless, pre-existing in the urine.

3rdly. The colouring-matter or matters occurring in normal urine, and to which its usual colour is due.

The first class is again subdivided by the author into blue, purple or red, and black or brown colouring-matters. The appearance of a blue colouring-matter in urine has been frequently observed, both in ancient and modern times. By some it has been taken for indigo-blue, by others for prussian blue, while several chemists maintain that it consists of a peculiar substance, to which the name of *cyanourine* has been applied. The red colouring-matter is generally found in association with deposits of urate of ammonia and urate of soda, to which it communicates a pink or carmine tinge. Proust called it *rosacic acid*, while recent observers have given it other names, such as *uroerythrine* and *purpurine*. Very little is known regarding its true chemical nature. Prout, indeed, suggested that it might be identical with purpurate of ammonia; but he advanced no good grounds in support of this view, and it was proved to be erroneous by Berzelius. Instances of black urine are even of rarer occurrence than those of urine coloured blue. Indeed in many cases the black colour appears to have been due to red or purple pigments which communicated to the urine so deep a tint as to make it appear black. The *melanic acid* of Prout seems, however, to have been a peculiar substance, though closely resembling, as remarked by Berzelius, the black pulverulent substance which is formed by the action of concentrated acids on the extractive matters of urine.

The second class of urinary colouring-matters, comprising those which are formed by artificial means and therefore do not preexist in the secretion, may also be subdivided according to colour—those which have hitherto been observed being either blue, red, or brown. The author concedes to Heller the merit of having first obtained from urine by artificial means colouring-matters of a pure blue or red tint; but the true nature of these colouring-matters, as well as of the process by which they are formed, was not understood by him. Subsequent researches have proved that the *uroglaucline* and *urorhodine* of Heller are identical with the indigo-blue and indigo-red obtained from vegetables. After mentioning the experiments of Hassall, who observed the formation in morbid urine of a blue colouring-matter which he showed to be indigo-blue, the author refers to his own researches. In a paper published several years ago, he showed that urine contained as a never-failing constituent a body closely resembling if not identical with indican, the indigo-producing body of vegetables, and that hence the formation of indigo-blue and indigo-red from urine might easily be explained. This result has been confirmed by Carter and others. The formation of brown colouring-matters by the action of acids on urine was first observed by Proust, who obtained by this means a brown resinous body and a black pulverulent substance. The same or similar bodies were obtained by Scharling and Liebig, as well as the author, who gave a general account of them in the memoir just referred to. The simultaneous formation of glucose, or at least of a body having the same action on oxide of copper as glucose, is a fact first observed by the author. From an ex-

mination of the composition of the brown pulverulent substance resulting from the action of strong acids on urine, the author infers that it may be expressed by the formula $C_{14}H_7NO_4$, which is also that of anthranilic acid, a product of decomposition of indigo-blue. All these products (the resin, the brown pulverulent substance which has received the name of *uromelanine*, and the glucose) are, in the author's opinion, derived from the extractive matter of urine, which by decomposition with acids yields these and perhaps other products. The conclusion formerly arrived at by the author, viz. "that the indigo-producing body will be found, as regards its formation and composition, to occupy a place between the substance of the tissues and the ordinary extractive matter of urine," is one which further research, as the author thinks, has only tended to confirm.

The urinary colouring-matters belonging to the third class, consisting of those to which the ordinary colour of the secretion is due, have been less frequently submitted to investigation than those which make their appearance only exceptionally or in consequence of some artificial process of decomposition. This circumstance may easily be accounted for. These so-called colouring-matters are all amorphous, and possess few characteristic properties; hence their separation from the other constituents of urine is attended with great difficulties, and has even been pronounced impossible. They are also compounds of very little stability—so much so that mere evaporation of the urine seems to produce a complete change in their composition, as is seen by the marked change of colour which takes place during the process. The opinions entertained on the subject by the earlier chemists, such as Fourcroy and Vauquelin and Proust, having been referred to, the author gives a short account of the experiments of Berzelius, Duvernoy, Lehmann, Scherer, Harley, Tichborne, and Thudichum. Berzelius and Lehmann both found the substance to which healthy urine owes its colour to be completely soluble in water. Subsequently, however, most of the attempts which were made to isolate the colouring-matter of urine ended in the separation of substances quite insoluble in water. These must in all cases have been products of decomposition; for the author considers it quite certain that the colouring-matters derived from urine which are insoluble in water are not contained as such in the secretion, provided the latter is in its normally acid state.

Having concluded his summary of the results obtained in previous researches, the author proceeds to give an account of his own experiments. Before doing so, he states that he shall apply the term "colouring-matter" to those bodies only which, occurring naturally in urine or else formed by processes of decomposition, are insoluble or not easily soluble in water, while the substances easily soluble in water to which the colour of normal urine is due, he shall continue for the present to call "extractive matters." The extractive matters being, in the author's opinion, the source whence most of the colouring-matters of urine are derived, he resolved to commence the investigation by a careful examination of their properties and

composition. Indeed the first step which he thought it necessary to take, before proceeding with the investigation at all, was to ascertain whether these extractive matters are bodies of a definite chemical nature, or whether they are merely accidental mixtures of various excrementitious substances thrown out by the system, and differing in their nature according to circumstances. In order to arrive at a positive conclusion on this point, several series of experiments were undertaken. The method devised for the purpose of separating the extractive matters from the other constituents of urine, and obtaining them in a state of purity, presents few features of novelty as compared with those previously employed. The experiments necessarily occupied a considerable time, since the author considered it essential, in order to avoid decomposition, to evaporate all the solutions at the ordinary temperature by means of a current of air. The certainty of the conclusions arrived at afforded, however, ample compensation for the loss of time and additional labour thus occasioned. The composition of the extractive matters was determined by analyzing their lead compounds, since the substances themselves cannot be obtained in a state fit for analysis.

From the experiments described in this part of his paper the author thinks he is justified in drawing the following conclusions :—

1. Human urine contains at least two peculiar and distinct extractive matters, one of which is soluble in alcohol and ether, while the other is soluble in alcohol, but insoluble in ether. The existence of an extractive matter insoluble both in alcohol and in ether is extremely doubtful.

2. The composition of these extractive matters varies slightly, without any corresponding difference in their appearance and properties being perceptible ; but these variations are not due to any difference in the quality of the urine or the source whence it was derived, but rather to the decomposition which takes place during the process employed in their preparation, and which cannot be entirely avoided.

3. When quite pure, the extractive matter soluble in alcohol and ether has a composition corresponding with the formula $C_{36}H_{51}NO_{52}$, while that of the extractive matter soluble in alcohol but insoluble in ether is expressed by the formula $C_{38}H_{27}NO_{28}$.

January 18, 1866.

Lieutenant-General SABINE, President, in the Chair.

The President stated that Dr. William Bird Herapath, who by reason of non-payment of his annual contribution ceased to be a Fellow of the Society at the last Anniversary, had applied for readmission. The Statute relating to the case was read, and, in accordance therewith, notice was given that the question of Dr. Herapath's readmission would be put to the vote at the next meeting.

The following communications were read :—